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ABSTRACT

In view of the consequences of the engineering faculty shortage problem on engineering capabilities in the future in the United States, a working plan which will serve as a national agenda for prompt action has been developed. This plan involves the three key groups (federal government, academic community, industry) who have the vision, leadership, and resources to implement a solution to the problem. The plan is organized into initiatives for these three groups. Federal government initiatives discussed include establishing a New Faculty Assistance Program, White House Engineering Fellowships, White House Professors, and a Federal Engineering Faculty Enrichment Fund. Academic community initiatives discussed include developing/implementing accreditation standards which establish goals to alleviate the faculty shortage, endorsing a policy statement encouraging top quality students to consider careers as engineering faculty, encouraging employment of qualified professionals from the private sector in engineering education, and others. Industry initiatives discussed include increasing educational contributions to universities to assist young faculty members, expanding financial support for research at universities, expanding industry/university relationships (through consulting, summer employment, sabbatical opportunities), and others. A summary of these initiatives in a form suitable for reproduction as viewgraphs or slides is included. (JN)

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A WORKING PLAN FOR

TREATING THE ENGINEERING

FACULTY SHORTAGE PROBLEM

May 1983

Prepared by a Special Task Force of AAES

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AAES -The American Association of Engineering Societies is a national organization headquartered in New York City representing nearly 1,000,000 engineers.

ASEE -The American Society for Engineering Education is a national organization headquartered in Washington, D.C. with a membership over 10,000 persons active in engineering education.

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*Task Force Co-Chairmen

PREFACE

The **crisis in engineering education** has been recognized, identified, categorized, studied, discussed, and reorganized in many ways. At several conferences the leaders of government, industry, and academia have made recommendations pertinent to the crisis. These recommendations for action have been published, distributed, and discussed widely. It is now time for deeds worthy of doing.

All members of the Task Force have been intimately involved with many aspects of the crisis. Through their contacts with other engineering leaders of the Nation, they have obtained counsel on this problem. The Task Force has drawn from the resources available (both in the form of oral comments and published statements) a concise working plan for attacking one of the most critical aspects of the crisis - the engineering faculty shortage problem.

In view of the consequences of the engineering faculty shortage problem on engineering capabilities in the future in the United States, a working plan which will serve as a national agenda for prompt action has been developed and is here presented. This plan involves the three key groups who have the vision, the leadership and the resources to implement a solution to the problem. This plan is organized into initiatives for these three groups.

In order to enhance the dissemination of this plan, the summary section has been prepared in a form suitable for reproduction as viewgraphs or slides. Readers of this report are encouraged to duplicate and use the summary section for this purpose.

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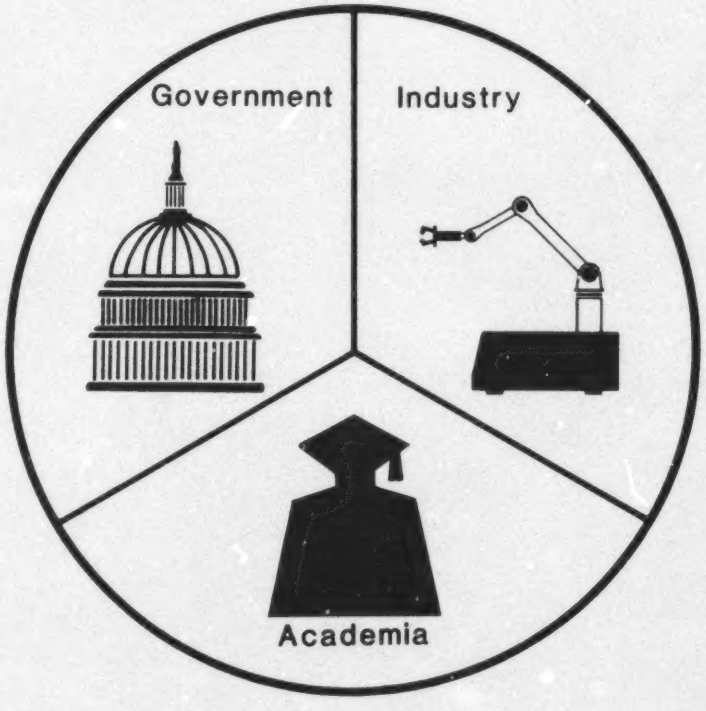
1.0 SUMMARY OF INITIATIVES

Initiatives to be Undertaken by the Federal Government

Initiatives to be Undertaken by the Academic Community

Initiatives to be Undertaken by Industry



1.1 INITIATIVES FOR THE FEDERAL GOVERNMENT

Establishment of a New Faculty Assistance Program

Establishment of White House Engineering Fellowships

Establishment of White House Professors

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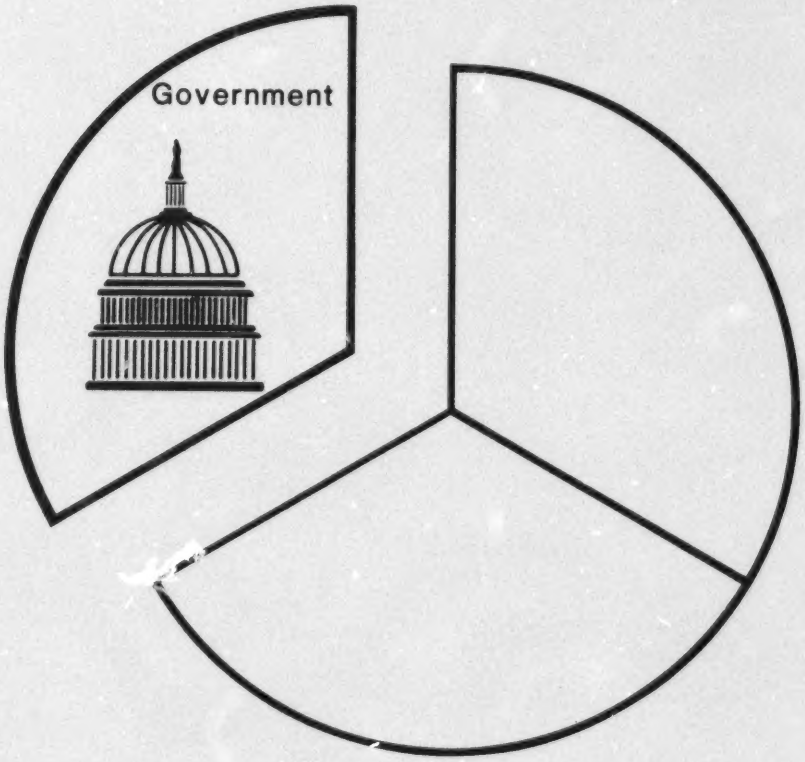

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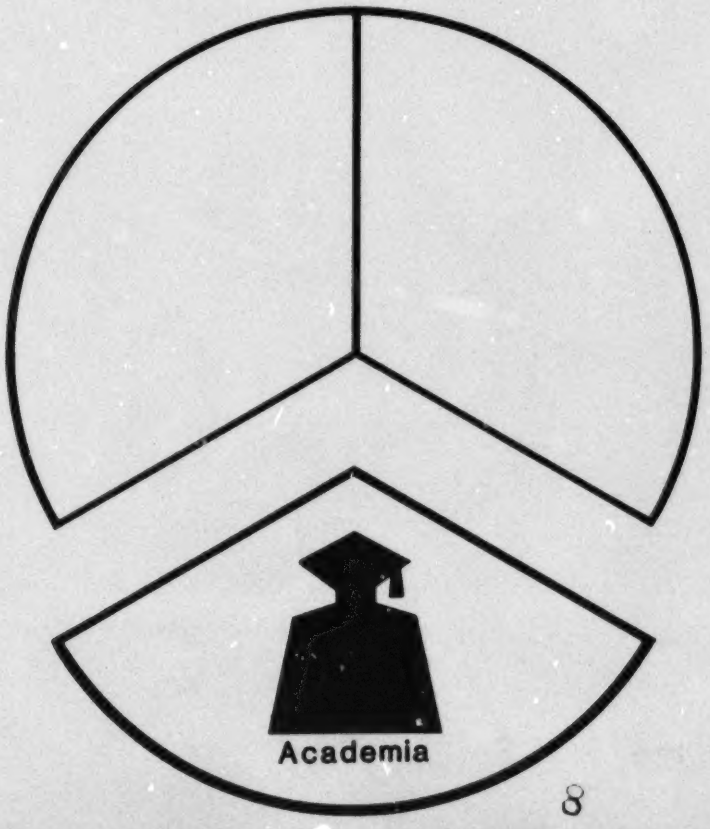

1.3 INITIATIVES FOR INDUSTRY

Encourage Organizations that Hire Engineers to Expand Their Graduate Fellowship Contributions to Universities

Increase Educational Contributions by Industry to Universities in Order to Assist Young Faculty Members

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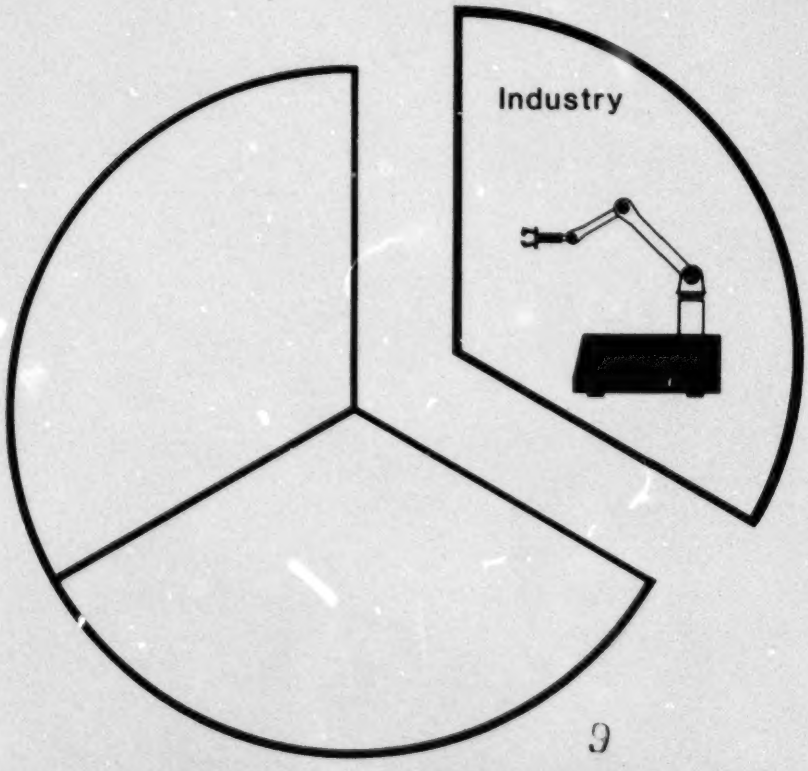
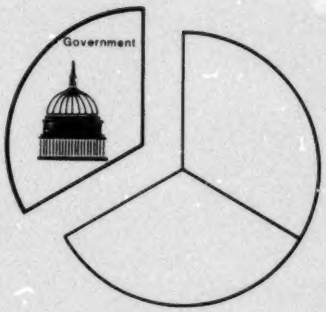


2.0 DETAILS OF THE INITIATIVES FOR THE FEDERAL GOVERNMENT



The shortage of engineering faculty for our nation's engineering colleges is serious. Projections indicate that it is a long-range problem that is getting worse. The primary reason that the problem is getting worse is that the number of U.S. born engineering graduate students studying for the doctorate degree in engineering has been decreasing and is much smaller than needed to maintain quality engineering education programs. This decrease in domestic graduate students has occurred at a time when our nation is dependent upon engineering graduates and their role in developing and applying new technology to increase the productivity of our nation and improve our quality of life. All indications are that in order for the United States to continue to be internationally competitive in the world marketplace and to maintain a viable defense posture, the supply of quality engineering graduates must continue to increase.

There are a number of factors which influence the attractiveness of engineering faculty positions to qualified individuals. These factors include salary, professional working conditions, university library resources, university computer resources, engineering laboratory equipment, magnitude of the teaching load, motivation of the students, attractiveness of the facilities, etc. It is impossible for the Federal Government to take steps to provide improvements in all of the factors. Yet, there are definite steps that the Federal Government should and could take in order to have a significant impact on the engineering faculty shortage. Indeed, the ONR fellowship program is an example of one step that has been taken.

The following initiatives are directed toward resolving the engineering faculty shortage problem. Action must be taken at this time since the engineering education system of our nation is beginning to deteriorate. All of the initiatives that are suggested require the universities to cooperate with the Federal Government through the procurement of non-federal funds to supplement the universities' contribution to these initiatives.

2.1 Establishment of a New Faculty Assistance Program.

The New Faculty Assistance Program is designed to increase the number of new doctoral engineering graduates accepting faculty appointments at the rank of assistant professor.

There is increasing evidence that newly graduated engineering doctorates are less interested in academic careers because of what they perceive to be a general deterioration of the academic environment. One of the contributing factors to this deterioration is the current high teaching load imposed on the faculty as a result of record numbers of undergraduate students without appropriate increases in faculty. This in part is the reason why there are currently approximately 1,000 vacant engineering faculty positions which are authorized at the assistant professor level.

To stimulate increased interest in academic appointments on behalf of high quality recent doctoral engineering graduates, it is proposed that a new faculty assistance program be initiated. The purpose of this program would be to lighten beginning assistant professors' teaching loads during the first two years of their appointment as well as ensure that summer salary is available in order that they might initiate their research and scholarly activities. This program would provide an assistance package to new assistant professors in the amount of $20,000 per year for the first two years of their appointment. The money would normally not be used to supplement the professors' base salary but could be used to provide summer support, release time during the academic year in order to reduce the teaching load, purchase of capital equipment necessary to initiate their research program, provide graduate student support, provide travel to professional meetings, or some combination of these positive supports.

Cost - One-half of the cost of this program would come from the Federal Government, namely $10,000 per year for a two year period or $20,000 per recipient. It is anticipated that the university contribution to the program would come from industrial grants and gifts. The program should fund 500 new assistant professor appointments each year for four years resulting in yearly federal expenditures for five years of 5, 10, 10, 10, and 5 million per year.

2.2 Establishment of White House Engineering Fellowships.

A special inducement is needed to make graduate study in engineering more attractive to United States citizens. During the past several years, young women and men who are highly qualified for graduate training in engineering have elected other career paths upon receiving their baccalaureate degree in engineering primarily because engineering graduate study is financially unattractive. It is proposed that White House Engineering Fellowships be developed as part of a long-range plan to increase the supply of engineers educated at an advanced level in the United States. These new engineers, educated to a higher level, will more effectively utilize our human resources and provide a pool of engineering doctoral graduates useful to United States industry, government laboratories, and private practice, as well as to the U.S. engineering colleges. Recent data indicate that only about one-fourth of the U.S. engineering graduates with doctorate degrees enter the academic marketplace.

U.S. citizens or permanent residents with or anticipating baccalaureate degrees in engineering from ABET (Accreditation Board for Engineering and Technology) accredited engineering programs should be encouraged to apply for a White House Engineering Fellowship through the Executive Office of the White House. Such an application would require an endorsement of acceptance of the student by the dean

of the engineering college where the student desires to enroll with fellowship support. A maximum of 1,200 White House Engineering Fellowships would be granted during each of the first two years. Six hundred White House Engineering Fellowships would be granted during each of the third, fourth, and fifth years of the program. These Fellowships would be granted at a stipend of $60,000, payable at $10,000/year for a period of up to four years or until the graduate student earns the engineering doctoral degree. Universities would be required to add at least $5,000 per year from sources such as private gifts, industry grants, normal revenue, etc. during a maximum of four years of the program while the graduate student completes the doctorate degree in engineering. Upon completion of the degree and employment as a full time engineering faculty member, the federal grant would continue for two years at $10,000/year with matching funds required from the universities and specified to be used for the professional development of the new engineering faculty.

Cost - The cost of this program to the Federal Government would be 12 million dollars for the first year with a total cost of 252 million spread over a ten year period. The university would require funds totaling 6 million dollars during the first year with a total cost of 168 million spread over 10 years.

2.3 Establishment of White House Professors.

Other sources of potential professorial talent within the country are in private industry, and government laboratories. There exists a reasonable number of highly qualified and interested individuals in these two areas who are currently in either the early or late part of their careers. The former may have elected to not choose academe because of the drastic economic differences between careers, but now find that they still yearn to do teaching and research, since their current jobs are not as satisfying as they expected. The latter may have made a significant technical contribution and are ready for a change, a new challenge of a different career nature. Therefore, we propose the following matching program designed to augment the initial few years of transition to academe; covering costs of employment interviews, relocation, and salary adjustments depending upon the individual's background.

Engineers in industry, private practice, National Laboratories, or other government positions should be encouraged to apply for a five-year appointment as a White House Engineering Professor. Applications should be made through the Executive Office of the White House and would require an endorsement by the dean of the engineering college where the appointment is desired. A one time infusion of a maximum of 400 White House Engineering Professors would take place during the first year. The appointments will be for five years at a stipend of up to $25,000 per year from the Federal Government. The exact amount to be determined by the engineering college taking into account the previous salary of the engineer. The federal stipend would be paid directly to the engineering college for distribution to the White House Engineering Professor. The university where the White House Professor is placed would be required to provide matching funds for the five year period. At the discretion of the university, some of the federal funds may be used for relocation of the new faculty or for paying the cost of fringe benefits for the new faculty.

This proposal would bring qualified, new engineering faculty into the engineering colleges and provide a small but significant boost in the engineering faculty supply for a five-year period. Applications would be restricted to new members of the engineering education profession and, therefore, current engineering faculty would be excluded from applying.

Cost - The cost of this program to the Federal Government would be 10 million dollars per year for a five-year period.

The cost of this program to the Universities would be 10 or more million dollars per year for a five-year period. The universities would obtain their matching funds from sources such as industry, private foundations, alumni, and their normal revenue sources.

2.4 Establishment of a Federal Engineering Faculty Enrichment Fund to Provide of an Inducement Through Matching Funds to Universities to Alleviate the Engineering Faculty Shortage Problem in Each State.

Universities should be encouraged with a free enterprise type of federal support to take positive steps to develop an action plan to encourage more graduate training of engineers and make engineering faculty positions more attractive to qualified individuals. Such an action plan would be a candidate for matching funding with federal funds, if backed by non-federal funds solicited by the universities and approved by the Executive Office of the White House. Since current expenditures for higher education by the states approximates 25 billion dollars per year, it is anticipated that a national impact on this engineering faculty crisis would require an expenditure of one billion dollars per year by the universities. It is recommended that federal funds be allocated at a maximum of 1.25 million per university over a five-year period.

One of the special features of a Federal Engineering Faculty Enrichment Fund is that it would also serve as an inducement for the universities and the States to direct their attention toward long-range plans for the development of high technology.

Cost - It is proposed that the federal government provide matching funds of up to 125 million over 5 years. The average cost would be 25 million per year.

SUMMARY

The four initiatives to be undertaken by the Federal Government which are described above all require a significant expenditure of non-federal funds by the universities. The universities would obtain their funds from sources such as individuals, private foundations, industry, state governments in the case of state supported universities, city governments for municipally supported universities, and combinations of these sources. In review, it is noted that the focus of the four initiatives are as follows:

1. Recruitment and retention of new engineering assistant professors
2. Development of new engineering doctoral graduates
3. Transfer of capable engineers from other positions into engineering faculty positions

4. Development of creative and innovative plans to alleviate the engineering faculty shortage which are based upon the local conditions in which each engineering college exists.

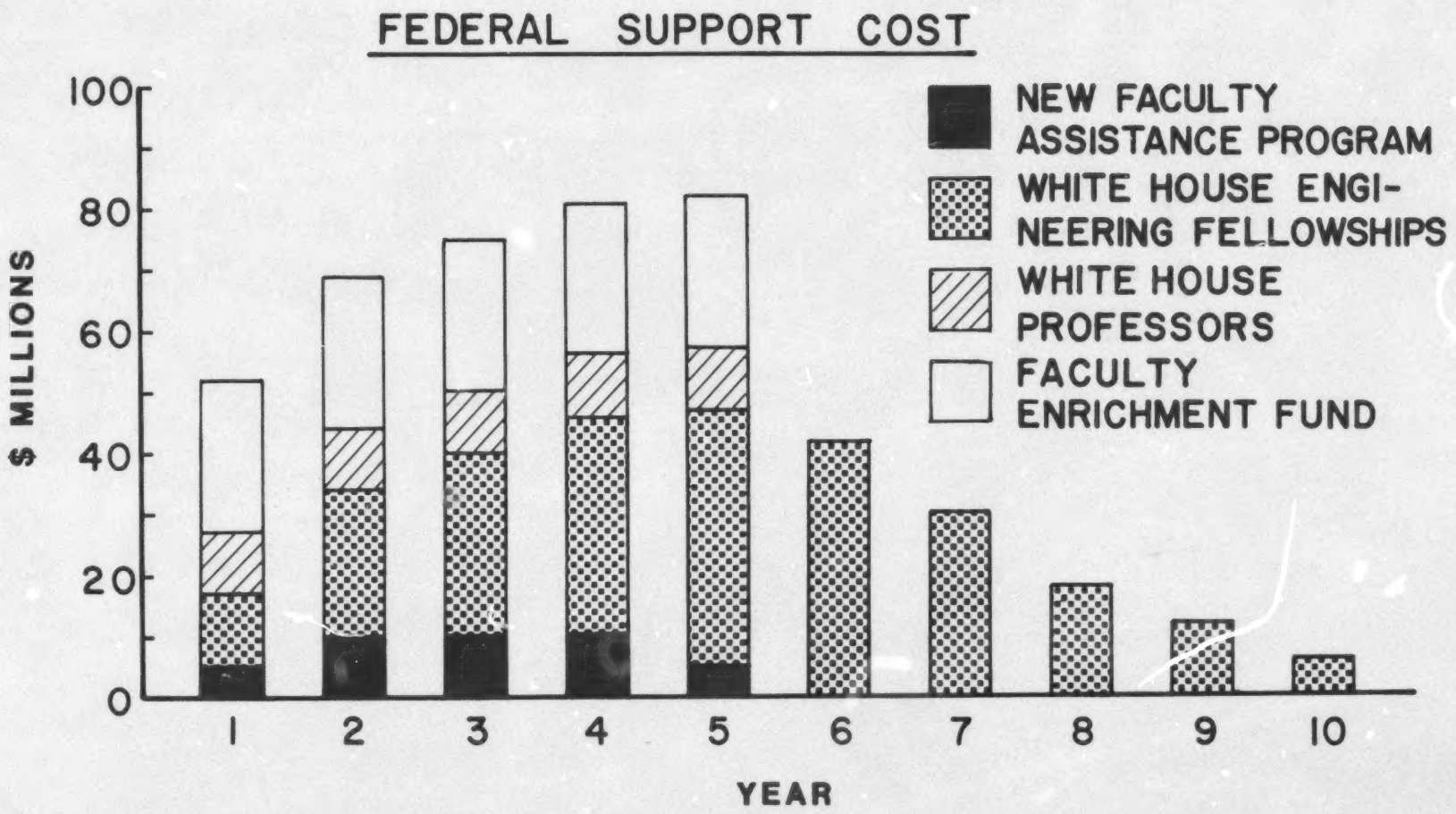
Prompt action on these four initiatives will be a significant step forward toward meeting a portion of the need for engineering faculty in the United States.

The cost of the four initiatives is insignificant with respect to the potential return to the United States and the potential loss to the United States if the engineering faculty shortage problem is not remedied. The federal cost for this program is graphically illustrated in the following table and figure.

FEDERAL INITIATIVES TO DIMINISH

THE U.S. ENGINEERING FACULTY SHORTAGE

INITIATIVE	FEDERAL SUPPORT COST ($MILLIONS)										
NAME	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	TOTAL
#1 - NEW FACULTY ASSISTANCE PROGRAM	5	10	10	10	5						40
#2 - WHITE HOUSE ENGINEERING FELLOWSHIPS	12	24	30	36	42	42	30	18	12	6	252
#3 - WHITE HOUSE PROFESSORS	10	10	10	10	10						50
#4 - FACULTY ENRICHMENT FUND	25	25	25	25	25						125
TOTALS	52	69	75	81	82	42	30	18	12	6	467


FEDERAL SUPPORT COST
$ MILLIONS
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
YEAR
NEW FACULTY ASSISTANCE PROGRAM
WHITE HOUSE ENGI-NEERING FELLOWSHIPS
WHITE HOUSE PROFESSORS
FACULTY ENRICHMENT FUND

3.0 DETAILS OF THE INITIATIVES FOR THE ACADEMIC COMMUNITY

The following initiatives should be accepted and pursued by the academic community as a step toward resolving the current critical shortage of qualified engineering faculty candidates and the shortage of engineering faculty at our universities.

3.1 Develop and Implement Accreditation Standards Which Establish Goals to Alleviate the Faculty Shortage.

The accrediting authority for engineering degree granting programs should develop and implement standards for program accreditation which establish as goals:

a) Full-time equivalent (FTE) student to full-time equivalent (FTE) faculty ratios reflecting the specific mission of programs.

b) Engineering faculty salaries that are, as a minimum, competitive with "marketplace" salaries of private industry for equivalent professional qualifications and responsibilities.

c) Modernization of instructional and research equipment and facilities in order to provide the capability for sustaining instruction based on current technology.

d) A faculty development plan which includes:

i) Required travel to and participation in professional meetings/seminars/workshops, etc.

ii) Positive interaction with professionals in the private or government sectors through consulting, summer work, sabbaticals, etc.

iii) Demonstrated involvement in improvements in teaching through the use of modern teaching aids, innovative methods of instruction, academic R&D, etc.

3.2 Endorse a Policy Statement Encouraging Top Quality Students to Consider Careers as Engineering Faculty Members.

The Engineering Deans Council of ASEE should draw up and endorse a policy statement to be presented to the engineering department chairmen groups for adoption. This policy statement should bring into focus, for the student, career opportunities as engineering faculty and should be disseminated through student honor societies of the various disciplines.

3.3 Encourage Support for the Dissemination of Information About the Current State of the Engineering Education Profession.

The engineering deans and their faculty colleagues should actively support the Commission on Education for the Engineering Professions of the National Association of State Universities and Land-Grant Colleges through assistance with program development and white-paper topic development to facilitate carrying the message of the state of the engineering education profession to the administrative officers of the universities.

3.4 Encourage Employment of Qualified Professionals from the Private Sector in Enginering Education.

The engineering deans and their faculty colleagues should encourage the employment of qualified professionals from the private sector in the faculty ranks. This employment can take many forms, including:

a) Use as adjunct faculty to bring to the students and university community special knowledge and skills and to support the faculty by teaching expanded/overloaded sections.

b) Inclusion as full-time members of the faculty where their in-depth experience and expertise complement the existing faculty body.

3.5 Encourage Quality in Engineering Programs Through Cooperation Among Universities and through the Use of New Techniques and Equipment.

The engineering deans and their faculty colleagues should make their best efforts to:

a) Expand the use of educational technology, particularly modern equipment (computers, instrumentation, control devices) and communication devices (closed-circuit television, video recordings, computer-programmed self-instruction, and teleconferencing) to give students knowledge of modern techniques and extend the availability and effectiveness of engineering faculty.

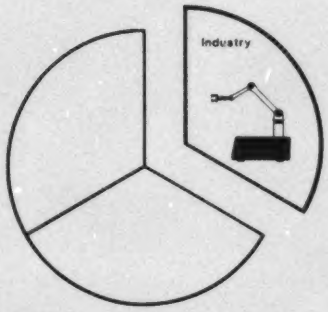
b) Provide faculty with time and new opportunities to initiate and maintain personal teacher-student contacts.

c) Share specialized capabilities at different schools.

d) Facilitate better use of graduate assistants and non-engineering faculty.

e) Seek funds from alumni and other sources to enhance the quality of the engineering programs.

4.0 DETAILS OF THE INITIATIVES FOR INDUSTRY



The following are suggested as the most appropriate ways for industry to help in resolving the engineering faculty problem.

4.1 Encourage Organizations that Hire Engineers to Expand Their Graduate Fellowship Contributions to Universities.

An additional 1,000 engineering Ph.D.'s, who are interested in and qualify for teaching, will be needed each year during the period 1985-1990 to restore faculties to satisfactory staffing levels. In 1981, it is estimated that 50,000 new bachelor-level engineers accepted non-academic employment: a ratio of 1/50. Since at least three years are required for the Ph.D., three graduate students must be in the pipeline for every 50 engineers that take non-academic jobs, changing the ratio to 1/17. As a guideline, then, each employer of engineers should seriously consider funding at least one additional graduate fellowship for every 17 engineers hired in an average year.

4.2 Increase Educational Contributions by Industry to Universities in Order to Assist Young Faculty Members.

High on the list of reasons for not taking an academic job are the problems of getting started as a new assistant professor. These include low starting salaries, no assured summer income, difficulties in getting research programs underway, lack of equipment, etc. Until the institutions themselves can find resources to alleviate these problems, employers of engineers can help to provide a transition by making grants for this purpose. If $20,000 of supplementary funding were to be provided to each of the 1,000 new faculty members a total of $20,000,000 per year or $400 for each of the 50,000 new engineers employed in non-academic jobs would be required. It is recommended that employers of engineers increase their educational contributions accordingly to accommodate this need.

4.3 Expand Financial Support of Research at Academic Institutions.

Financial support of research at academic institutions is attractive to industry for numerous business-related reasons, but it also helps the "engineering crisis" problem by providing graduate student support, faculty salary supplements, equipment money, etc. Some companies today are spending as much as one percent of their R & D budgets in this manner. With the university climate changing, this is an opportunity that more companies could exercise to their advantage.

4.4 Expand The Interactions Between University Faculty Members and Industry Through Consulting, Summer Employmemt, and Sabbatical Opportunities.

Faculty knowledge of modern engineering practices can be augmented and faculty income can be improved at the same time by hiring professors as consultants or as summer employees, or by providing them opportunities to take sabbaticals in industry. All of these mechanisms are in common use today. Industry should seek means for expanding such activities.

4.5 Provide Assistance to Engineering Schools or University Administrators in Presenting Funding and Related Problems to Boards of Trustees, Regents, or State Legislatures.

Industry can be of assistance in presenting engineering school funding and related problems to boards of trustees, regents or state legislatures. Universities should not hesitate to request such help when they judge it to be useful. Industry, in turn, should cooperate fully when asked.

4.6 Provide Educational Assistance in the Form of Personnel, Donated Equipment, Access to Industrial Facilities, Special Workshops, and Professional Involvement.

There are numerous ways that industry can assist in improving the quality of engineering education. They can encourage employees to serve as occasional lecturers, as adjunct faculty, or as members of departmental or engineering school advisory committees. They can donate laboratory equipment, or provide access to industrial facilities. They can conduct workshops for faculty or provide teaching aids of various kinds for classroom use. Companies not now providing such help should seek opportunities for doing so, and those already involved should look for ways to expand such services. Companies should become more active in the educational activities of engineering societies.

5.0 EPILOGUE

This working plan was developed by the Task Force in the summer of 1982. The initiatives for the Federal Government were presented in September 1982 to Dr. George A. Keyworth, President Reagan's Science Adviser. In October of 1982 at the 50th Anniversary Meeting of ABET, the federal plan was discussed and comments on drafts of the plan for the academic community and industry were requested. The initiatives for the academic community and industry were published as drafts in the January 1983 issue of Engineering Education News.

The Task Force Co-Chairmen received numerous helpful comments concerning these initiatives and have incorporated the wisdom of many concerned individuals into this final document.

Of special note is the fact that President Reagan's State of the Union message called attention to engineering education and the President's '84 budget has responded to the suggested initiatives for the Federal Government through the Presidential Young Investigator Awards. Also of note is the strong interest developing in Congress with various pieces of proposed legislation designed to strengthen the delivery system for engineering education in our nation.

Action is needed. There are indications that the Federal Government, the academic community, and industry are responding to crisis. Now that the action has started, this working plan provides the initiatives for the three key groups to treat synergistically the problem and put into play those actions which will ease the engineering faculty shortage and over the long term restore quality to engineering education.